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July 6, 2005

Mail Stop Certificate of Corrections Branch
Commissioner for Patents
P.O. Box 1450
Alexandria, VA 22313-1450

Re: U.S. Patent No.:6,863,151
Issued: March 8, 2005
Inventor: Christoph Widmer, Joydeep Dutta
Our Docket:32784US4

Certificate
JUL 14 2005
of Correction

Sir:

A Certificate of Correction under 35 U.S.C. 255 is hereby requested to correct printing errors in the above-identified patent. Enclosed herewith is a proposed Certificate of Correction (Form No. PTO-1050) for consideration along with appropriate documentation supporting the request for correction.

It is requested that the Certificate of Correction be completed and mailed at an early date to the undersigned attorney of record. The proposed corrections are obvious ones and do not in any way change the sense of the application.

I hereby certify that this correspondence is being deposited with the United States Postal Service as first class mail in an envelope addressed to: Mail Stop Certificate of Corrections Branch, Commissioner for Patents, P.O. Box 1450, Alexandria, VA 22313-1450 on the date indicated below.

Michael W. Garvey		6 Jul 05
Name of Attorney for Applicant(s)	Signature of Attorney	Date

07/12/2005 AADOFD1 00000049 6863151
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JUL 15 2005

We enclose our check in the amount of $100 as required under 37 CFR 1.20(a). If there are any additional fees resulting from this communication, please charge said fees to deposit account 16-0820, order no. 32784US4.

Very truly yours,

Michael W. Garvey, Reg. No. 35878

MWG/jl
Enclosures

JUL 15 2005

PTO/SB/44 (07-03)
U.S. Patent and Trademark Office; U.S. DEPARTMENT OF COMMERCE
(Also Form PTO-1050)

UNITED STATES PATENT AND TRADEMARK OFFICE
CERTIFICATE OF CORRECTION

PATENT NO. : 6,863,151 PAGE 1 OF 1

DATED : March 8, 2005

INVENTOR(S) : Christoph Widmer, Joydeep Dutta

It is certified that error appears in the above-identified patent and that said Letters Patent is hereby corrected as shown below:

On the cover page:
Item (57) Abstract, please delete "haring" and insert therefor –hearing–.

Column 5, line 43, please delete "only", and insert therefor –Only–.

Column 5, line 59, please delete "S_1.", and insert therefor –S_1,–.

Column 7, line 23, please delete "ca", and insert therefor "–cap–.

Column 8, line 67, please delete "20".

Column 9, line 64, please delete "asacoustical", and insert therefor –as acoustical–.

Column 10, line 31, please delete "haring", and insert therefor –hearing–.

Column 11, line 15, please delete "maybe", and insert therefor –may be–.

Column 11, line 40, please delete "57i", and insert therefor –57;–.

Column 11, line 46, please delete "59 designed" and insert therefor –59 is designed–.

Column 14, line 3, please delete "stub", and insert therefor –sub–.

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PATENT NO. 6,863,151

No. of additional copies
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JUL 15 2005

OIPE

Method for Manufacturing an Ear Device and Ear Device

CROSS-REFERENCE TO RELATED APPLICATION

[1] This application is a Continuation of U.S. Patent Application Serial No. 10/373,906, filed February 25, 2003, which is a Continuation of U.S. Application Serial No. 09/670,207 US (filed September 25, 2000 which is a continuation in part of 09/607,701 filed June 30, 2000. US

FIELD OF THE INVENTION

[2] The present invention relates to a method for manufacturing an ear device and to an ear device with a shell that consists of a layer of solidified thermal plastic material.

[3] The present invention is based on the problems arising in manufacturing of in-ear hearing aids. However, the solution as found is generally applicable to ear devices as defined further below.

BACKGROUND OF THE INVENTION

[4] When manufacturing hearing aid shells today typically audiologists produce a model of the shape of the individual auditory canals, thereby taking a mold thereof, typically of silicon. This model is then sent to the hearing aid manufacturer who on the basis of this basis casts a hearing aid shell from a plastic material.

[5] This procedure is problematic under different aspects:

[6] Based on the mold plastic materials must be used for the shell making, which result in a shell which is relatively hard and stable with respect to its shape. This as a result leads to the fact that when inserting the finished in-ear hearing aid into an individual's ear, on account of the remaining pressure spots, the shell of the hearing aid must practically always be refinished.

[7] Even though the above procedure allows making the resulting relatively hard shell with an outer shape matching the mold, it does not allow making complex inner and/or outer shapes such as would be desirable for configuring in an optimal manner the shape of mounts for the hearing aid's functional components. We understand under the expression "functional components" all units which are provided for reception, processing and reproduction of audio

D_2 it produces the layer S_2 corresponding to a further individual contour. Obviously several lasers can be moved together as one unit and accordingly more than one individual ear device can be produced simultaneously. only after the lasers 5 have produced the particular individual layers in all the positions, a new layer of powder is deposited by means of a powder supply indicated in general manner by 9, when laser sintering is used, while (not shown in the figure) when laser- or stereolithography is used, the solidified layers S are lowered in the bed of liquid.

[53] As shown in Fig. 2 sectional layers of individual ear devices or of their shells are solidified simultaneously at one or several liquid or powder beds 1 by means of simultaneously and individually controlled lasers 5. Following this solidification and after shutting off the lasers, the powder source 9 again deposits a new layer of powder, whereas in the case of laser- or stereolithography the just solidified sectional layers or the already solidified build-ups are lowered into the liquid bed.

[54] According to Fig. 3 the laser 5 solidifies the layer S_1. at the one powder or liquid bed la and then switches over to the bed 1b (dashed lines), where, during the solidification cycle at bed la, the powder depositing source 9b deposits powder over a previously solidified layer S_1 or, as regards laser- or stereolithography, the layer S_1 is being lowered. Only when the laser 5 becomes active at the bed 1b the powder source 9a deposits a new layer of powder over the just solidified layer S_1 at the bed, la, or the layer S_1 is lowered in liquid in the bed 1a. When using the thermojet process and in order to similarly increase productivity, sectional layers of more than one ear device or of their shells are simultaneously deposited, i.e. in one stroke by one deposition head, or, when in parallel, by several such heads.

[55] The above discussed method allows implementing highly complex shapes of ear devices or of their shells, both as regards their external shape with individual matching to the application area and, as regards a shell, its inside shape. Overhangs, recesses and protrusions are easily implemented.

[56] Moreover materials are known for additive built-up processes which can be shaped into rubbery, elastic and yet shape-stable shells which, where desired, may vary locally in wall thickness down to extremely thin walls while nevertheless being resistant to tearing.

[60] Considering that the described procedures for manufacturing ear devices are known, but only for rapid prototyping and are described in the literature, they need not be discussed herein in all their technical details.

[61] Surprisingly, however, by taking these known rapid prototyping techniques over into industrial and commercially acceptable manufacturing of ear devices, very substantial advantages are attained on grounds which per se are not significant in rapid prototyping, for instance the elasticity of the thermoplastic materials, the possibility to individually create exceedingly thin walls, etc.

[62] In summary, the use of the cited additive built-up processes in manufacturing of ear devices or of their shells makes it possible to integrate thereat various functional elements which are laid out at the computer when designing the ear device and which are integrally produced as the ear device or its shell is built up. Conventionally such functional elements have been fitted into or joined to the finished ear device or to its shell, which may be recognized by material interfaces or by inhomogeneities in the material at link areas of such components to e.g. the shell.

[63] As regards the cited ear devices, especially those provided with electronics such as hearing aids, and especially in-ear hearing aids, components which can be directly integrated by the proposed technique into the ear device or its shell are e.g. seats and fasteners for components, ear-wax protection systems, venting channels or grooves for in-ear ear devices, supports which position in-ear ear devices in the auditory canal as so-called claws or channel locks.

[64] Fig. 4 illustrates in a schematic manner an in-ear ear device 11, e.g. an in-ear hearing aid, at which the acoustic output 13 to the ear drum is protected by an earwax protection ca 15. This protection cap 15 heretofore has been mounted during manufacturing as a separate part onto the shell 16 of the ear device 11, being affixed e.g. by gluing or bonding. As shown in a similar view in Fig. 5, when using the above mentioned additive built-up processes, the earwax protection cap 15a is directly integrated to the shell 16a of the otherwise identical in-ear ear device 11a. At the link area schematically denoted by P in Fig. 4, where, in the conventional technique, necessarily an inhomogeneity in the material is present, or a material

The above discussed additive built-up processes are especially well suited for such purposes. In order to further optimize the acoustical effects of the venting slots, the most varied acoustical impedances may be implemented along the novel venting slots, which is as an example shown at the slot 29 of Fig.8, which, propagating in its longitudinal direction, defines for different profiles, combined as desired and according to Fig. 8, from profiles according to Fig. 7.

[76] Similarly to the configuration of passive electric circuits, the resultant acoustical transfer behavior of the slot abutting the auditory canal can be computer modeled and checked and then be integrated into the in-ear ear device or its shell.

[77] One can provide sections of the device which are provided with an increased earwax protection there where such sections are especially exposed to earwax, as is shown in 20Fig. 8 at A.

[78] Furthermore, it might be highly desirable, especially with an eye on optimizing the acoustical behavior, to tailor the venting slots longer than would be possible from the actual length of a particular in-ear ear device. As shown in Fig.9 this goal is attained in that such slots 31, realized as e.g. shown in Figs. 7 and 9, run along predetermined curves along the surface of the ear device, for instance as shown in Fig. 9, practically as slots helically wound around the ear device. Additional flexibility of optimization is reached in that more than one venting slot are run along the ear device surface as schematically shown in Fig. 10. Because of the high design flexibility reached, regarding the venting slots, such slots may be differently dimensioned according to the respective application area in the auditory canal, with respect to earwax protection and to acoustical behavior and thus may be realized in an optimized manner along the surface of an ear device.

2b. Venting systems with fully integrated channels

[79] This embodiment of the novel venting system is based on venting channels which at least along parts thereof are fully integrated into the ear device and which are thus closed there towards the wall of.the auditory canals. This system will be elucidated below in relation

acoustical impedances are implemented so as to optimize the acoustical transfer behavior. Be it borne in mind in this respect and in context with section 5) below, that because complex acoustical impedances may be realized, venting channels or slots, but especially closed channels as addressed in this section of the description, can easily be utilized simultaneously and at least along parts thereof asacoustical conductor segments at the output side of active electromechanical transducers, as e.g. at the output side of microphones, e.g. in in-ear hearing aids.

[84] In analogy to the Figs. 9 and 10, Fig. 13 and 14 show how, on one hand, the integrated venting channels as described in this section of the description, can be extended by selecting a commensurate path along a respective ear device 43 and, on the other hand, how two or more such channels, where appropriate fitted with different and/or varying channel cross-sections, in analogy to Fig. 12, can be integrated in the ear device.

[85] By the design shown in the sections 2a) and 2b), which are combinable according to respective needs, the expert is given access to a huge number of embodiment variations of novel venting systems and in particular to a large number of degrees of freedom on account of the different parameters each dimensionable per se to individually create optimal protection against earwax and optimal acoustical transfer behavior for respective individual ear devices. In all embodiments preferably the specific individual system configuration is calculated or computer modeled to meet the cited requirements. Thereupon the individual ear device is manufactured. Again the initially cited additive built-up processes, as known for rapid prototyping, are especially appropriate, controlled by the optimized modeling result.

3. Ear devices optimized with respect to shape stability

[86] This section discloses novel ear devices optimally matching the dynamics of the sites of use, i.e. the application area. It is e.g. known that conventional in-ear ear devices cannot meet the requirements of the comparatively large movement dynamics of the auditory canal for instance during chewing, because they exhibit substantially the same shape stability all along the device. Similarly e.g. the acoustical conductors between outside-the-ear haring aids

[90] In lieu of or complementing the desired wall reinforcement and the design of the desired flexural or torsional behavior, in short the shape behavior of in-ear ear devices, the inner rib pattern can be complemented as shown in Figs. 17 and 18 by an external rib pattern. For that purpose and as shown in Figs 18 and 19, a pattern of ribs 51 is manufactured on the outside of the ear device 49, where called for, with zones of varying density, direction and cross-sectional profile.

[91] As shown in Fig. 19 such complementation maybe implemented in ear devices with a cavity, but also in ear devices lacking such cavities, which do not hold e.g. electronic components, namely e.g. in hearing protection and in water protection ear devices. Such an ear device is shown in a schematic cross-sectional view in Fig. 20. Therein the inside space 53 consists of an extremely compressible absorbing material which is enclosed by a shape-subtending shell skin 55 which is provided with the rib pattern 57. Both the "skin" 55 and the rib pattern 57 are jointly and integrally manufactured. Again the initially cited manufacturing processes are appropriate for this purpose, with resort to additive built-up techniques. To what extent in the near future such additive built-up processes can be implemented on one workpiece while changing the processed materials remains to be seen. If it should become possible to do so, it will be feasible, for instance as regards the embodiment of Fig. 20, also to build up the filler 53 simultaneously with the shell skin 55 and the ribs 57 as a respective sectional layer.

[92] Figs. 18 and 19 in particular show that by means of the external rib pattern, it is possible to simultaneously form venting slots or free venting spaces as indicated in schematic and illustrative manner by the arrow P.

[93] As regards Fig. 20, if required and as indicated by dashed lines at 57_i, it is quite feasible to fit the shell skin 55 with an inner rib pattern 57_i even when the in-ear ear device is filled with material, that is when it is not intended to receive further components, for instance electronic ones. Furthermore and as indicated in dashed lines 59 in Fig. 20, ear devices also can be manufactured which leave free a cavity to receive units such as electronic components, but wherein the intermediate space between such a cavity 59 designed

practice to couple on one hand acoustical/electrical input transducers or electro/acoustical output transducers provided therein on their input side or their output side respectively by means of acoustical conductors, which are assembled as independent parts in the form of tubular structures, to, on the other hand, the ambient of the hearing aid or, in particular as regards the input acoustical/electrical transducer, to mount them with their reception surfaces adjacent to the surface of the hearing aid, possibly only separated by minor cavities and protecting devices towards the ambient.

[106] Thereby when conceiving such hearing aids there is present a relatively large dependency, where in the hearing aid the converters and where in the hearing aid the coupling openings to the ambient are placed. it would be highly desirable to have largest possible conceptual freedom with respect to placing coupling openings to the ambient and placing the said converters or transducers within the hearing aid.

[107] This goal is principally attained in that the acoustical conductors mentioned - at the input side of the acoustic/electrical converters or at the output side of the electrical to acoustical converters - are integrated into the ear device or in the wall of the ear device shell.

[108] This feature is shown purely schematically in Fig. 25. A converter module 75 comprises an acoustical input or output 77. The shell 79 of the ear device of an in-ear or of an outside-the-ear hearing aid or of a headphone comprises, as an integral part, an acoustical conductor 81. This acoustical conductor is embedded at least to a part and as shown in Fig. 25 within the wall of the ear device shell 79. By means of acoustical stub conductors or conductor segments 83 preferably the respective acoustical impedance of the acoustical conductor 81 is matched. When applied to outside-the-ear hearing aids, this concept makes it possible to implement acoustical input apertures 85 distributed along the ear device and there where desired, and to couple such apertures via acoustical conductors 89, which are integrated in the ear device or its shell 87 to the acoustical/electrical converters 91 as provided and essentially independent therefrom, where such converters 91 are placed within the ear device. Thus in Fig. 26 there is e.g. shown how two converters are centralized to one module and their inputs are connected to the desired apertures 85 by acoustical conductors 89 respectively tailored. From consideration of the Figs. 25 and 26 as well as of the explanations